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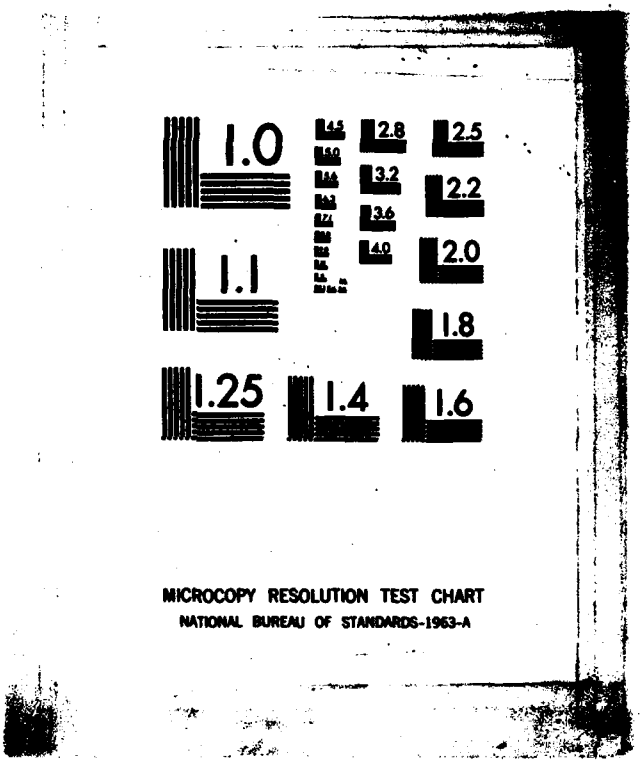
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ELASTOMERS AND OTHER ORGANIC COMPOSITES

FINAL REPORT

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The objective of this program was to bring together five investigators whose expertise was in the area of polymer synthesis, characterization, rheology and processing, solid state morphology and mechanical behavior and surface science. This abstract will describe some highlights of research findings and potential applications. In addition, in an appendix we have included statistics on publications, preprints and theses.

Butadiene-isoprene copolymers and their hydrogenated derivatives were examined. It was demonstrated that the block copolymers could be designed to provide a balance of chain scission and crosslink degradation behavior. This may be important in a variety of applications including vehicle treads. The block isoprene copolymers were also hydrogenated to yield interesting semi-crystalline thermoplastic elastomers. Fundamental aspects of anionic polymerizations have been studied which allow the control of molecular weight, molecular weight distribution and functional end groups. Such intermediates have promise for the synthesis of new elastomer components including possibly hybrid polyurethane cast pads that would have selective surface structure. Soluble difunctional initiators which can be used as intermediates to elastomers and polyols have also been studied.

Liquid crystalline copolymers are of great current interest and have already been demonstrated to be important reinforcing fibers for both elastomers and composites. This study has principally dwelt upon the relationships between chemical structure, rheology, morphology, and mechanical behavior. In addition, thermotropic polyesters and their blends with conventional PET have also been examined and show promise as advanced materials.

Inverse gas chromotography (IGC) has been used to probe polymer coatings with a variety of organic liquids as the mobile phase. Depending upon the relative retention times, important thermodynamic behavior can be derived. This has applications in the swelling of polymers and elastomers and also in the transport of agents through solid polymeric films. A second important technique that has been studied and further developed by this research is solid state NMR. This method has the ability to identify and define chemical structure and possibly molecular motion in elastomers, glasses and various network structures.

Polyisobutylene ion containing copolymers containing sulfonate end groups were investigated. Trifunctionality allowed for excellent mechanical properties as a combined result of ionic associations and strain induced crystallization. The ionic reinforcing phase could lead to new elastomeric materials with interesting transport properties that could possibly catalyze the decomposition of liquid agents.

Copolymerization of dimethyl and trifluoropropyl methyl siloxane elastomersystems shows promise for producing a low glass transition temperature (-60°C) that can be designed to show low swelling in hydrocarbons. Cycloaliphatic linked urea copolymers were synthesized which were transparent candidates for light stable elastomeric coatings. Additional work has been done in identifying and developing chemistry for matrix resins. A dielectric unit has been constructed which will be suitable for monitoring the cure or network formation for a variety of thermosets. These would include polyimides, epoxys, and elastomer networks.

Finally, extensive research has been conducted in the area of surface science which has included ESCA, SEM, and EDAX type techniques. There has been extensive instrumentation development and currently a Kratos-unit is operative. Information on the composition of surfaces versus bulk in elastomers and composites has been generated. This information has wide applicability with respect to elastomer or composite properties and systems such as tank treads. It can identify variations in compounding and also in surface oxidation by comparing, for example, oxygen to carbon ratios before and after various experiments. The general area of applying surface science to failure mechanisms has been developed significantly in this period and several good applications have been identified.

APPENDIX

(A) Publications

1. Editor, "Anionic Polymerization: Kinetics, Mechanisms and Synthesis," 592 pages, ACS Symposium Series, No. 166, November, 1981.

2. Co-Editor, "Photo, Electron and Ion Probes of Polymer Structure and Properties", ACS Symposium Series, No. 162 (1981).

3. Editor, "Ring Opening Polymerization: Kinetics, Mechanisms and Synthesis", ACS Symposium Series, in preparation, 1984.

4. J. E. McGrath, An Introduction and Overview of Block Copolymers, in "Block Copolymers", D. J. Meier, Editor, MMI Press (1983), p. 1-12.

5. J. E. McGrath, "Synthesis of Block, Graft, Segmented and Ion Containing Copolymers", Pure and Applied Chemistry, Vol. 55(10), 1573-1585 (1983).

6. I. C. Wang, Y. Mohajer, T. C. Ward, G. L. Wilkes, and J. E. McGrath, "Anionic Copolymerization of Butadiene and Isoprene with Organolithium Initiators in Hexane", ACS Symposium Series, J. E. McGrath, Editor, "Anionic Polymerization: Kinetics, Mechanisms, and Synthesis", No. 166, 529-555 (1981).

7. M. K. Martin, T. C. Ward, and J. E. McGrath, "The Reactivity of *Polydiene Anions with Divinylbenzene*", ACS Symposium Series, J. E. McGrath, Editor, "Anionic Polymerization: Kinetics, Mechanisms, and Synthesis", No. 166, 557-580 (1981).

8. A. K. Banthia, D. Lunsford, D. C. Webster and J. E. McGrath, "Interfacial Synthesis Part 1: Phase-Transfer Catalyzed Synthesis of Polyhydroxy Ether", J. Macromol. Sci.-Chem., A15(5), 943-966, (1981).

9. J. S. Riffle, R. G. Freelin, A. K. Banthia, and J. E. McGrath, "Interfacial Synthesis Part II: Phase-Transfer Catalyzed Synthesis of Polycarbonate/Polysiloxane Block Copolymers", J. Macromol. Sci.-Chem., A15(5), 967-998, (1981).

10. T. C. Ward, D. P. Sheehy, J. S. Riffle, and J. E. McGrath, "Inverse Gas Chromatography of Polycarbonate-Polydimethyl Siloxane Block Copolymers, Macromolecules, 14(6), 1791-1797, (1981).

11. Y. Mohajer, G. L. Wilkes, I. C. Wang, and J. E. McGrath, "Hydrogenated Linear Block Copolymers of Butadiene and Isoprene: Effects of Variation in Composition and Sequence Architecture on Properties," Polymer (London), 23(10, 1523-1536 (1982).

12. S. Abouzahr, Y. Mohajer, G. L. Wilkes, and J. E. McGrath, "Chemorheology of Butadiene-Isoprene Block Copolymer Networks", Polymer (London), 23(10), 1519-1523 (1982).

13. J. S. Riffle, E. Shchori, G. Freelin, T. C. Ward, and J. E. McGrath, "Synthesis of Hydroxyl Terminated Polycarbonates of Controlled Molecular Weight," J. Polymer Sci. (Chemistry Edition), 20, 2289-2301 (1982).

14. Y. Mohajer, I. C. Wang, G. L. Wilkes, and J. E. McGrath, "Hydrogenated Linear Block Copolymers of Butadiene and Isoprene: Dynamic Mechanical Behavior, in "Elastomers and Rubber Elasticity," J. Lal and J. E. Mark, Editors, Polymer Symposium Volume Series, p. 120-154 (1982).

15. I. Yilgor, J. S. Riffle, G. L. Wilkes, and J. E. McGrath, "Siloxane-Urea Segmented Copolymers. I. Syntheses and Characterization of Model Polymers for MDI and α,ω Bis(Aminopropyl)Polydimethyl Siloxane", Polymer Bulletin, 8, 535-542, (1982).

16. D. Tyagi, I. Yilgor, G. L. Wilkes, and J. E. McGrath, "Siloxane-Urea Segmented Copolymers. II. Mechanical Behavior", Polymer Bulletin, 8, 543-550, (1982).

17. D.J.T. Hill, J. H. O'Donnell, P. W. O'Sullivan, J. E. McGrath, I. C. Wang and T. C. Ward "Anionic Copolymerization of Butadiene and Isoprene: Applicability of the Terminal Model to High Conversion," Polymer Bulletin, 9(6/7), 292-298 (1983).

18. J. E. McGrath, J. S. Riffle, I. Yilgor, A. K. Banthia and G. L. Wilkes, "An Overview of the Polymerization of Cyclosiloxanes," Initiation of Polymerization, ACS Symposium Series, No. 212, 145-173 (1983).

19. R. E. Jerman and D. G. Baird, "Rheological Properties of Copolyester Liquid Crystalline Melts. Part I. Capillary Rheometry," J. Rheol., 25:2, 275-292 (1981).

20. D. G. Baird and G. L. Wilkes, "Thermotropic Liquid Crystalline Copolyesters - Rheological Properties," ACS Preprints, 22:2, 357 (1981).

21. E. Joseph, G. L. Wilkes and D. G. Baird, "Morphological Studies of Thermotropic Liquid Crystalline Polyesters Based on Polyethyleneterephthalate and Parahydroxy Benzoic Acid," ACS Preprints, 22:2, 239 (1981).

22. D. G. Baird, "Rheological Properties of Thermotropic Liquid Crystalline Copolyesters," Proceedings from the Second World Congress of Chemical Engineers, Vol. VI, Montreal Canada, October 4-9, 1981.

23. D. G. Baird and G. L. Wilkes, "Sandwich Injection Molding of Thermotropic Copolyesters and Filled Polyester," NATEC Papers, Society of Plastics Engineers, Bal Harbor, Florida, October 1982.

24. D. G. Baird and C. D. Nguyen, "Mold Filling Studies on Thermotropic Liquid Crystalline Copolyesters," Soc. Plast. Engr. Tech. Papers, May 1983.

25. D. G. Baird and G. L. Wilkes, "Sandwich Injection Molding of Thermotropic Copolyesters and Filled Polyester," Polym. Engr. & Sci., 23:11 (1983).

26. D. G. Baird, A. Gotsis, G. Viola, "Transient Shear Flow Behavior of Thermotropic Liquid Crystalline Copolyesters," ACS Preprints, Washington, D.C. Meeting, August 1983.

27. A. Gotsis and D. G. Baird, "Rheological Properties of Copolyester Liquid Crystalline Melts. Part II. Comparison of Steady Shear and Dynamic Oscillatory Behavior," Submitted to Journal of Rheology.

28. G. Viola and D. G. Baird, "Comparison of the Predictions of Ericksen's Transversely Isotropic Fluid Theory with Transient Flow Properties of Thermotropic Liquid Crystalline Copolyesters," Submitted to the Journal of non-Newtonian Fluid Mechanics.

29. D. G. Baird and G. L. Wilkes, "Sandwich Injection Molding of Thermotropic Copolyesters and Filled Polyester", Polym. Engr. & Sci., 23:11 (1983).

30. Y. Mahajer, D. Tyagi, G. L. Wilkes, R. F. Storey and J. P. Kennedy, "New Polyisobutylene Based Model Ionomers, 3. Further Mechanical and Structural Studies", Polym. Bull., 8, 47 (1982).

31. S. Bagrodia, Y. Mahajer, G. L. Wilkes, R. F. Storey and J. P. Kennedy, "New Polyisobutylene Based Model Ionomers, 4. Strain Induced Crystallization of Low Molecular Weight Model Ionomers",

32. Ibid, 8, 281 (1982).

33. S. Bagrodia, Y. Mohajer, G. L. Wilkes, R. F. Storey, and J. P. Kennedy, "New Polyisobutylene Based Model Ionomers, 5. The Effect of Molecular Weight on the Mechanical Properties of Tri-arm-star Polyisobutylene Base Model Ionomers", Ibid, 9, 1974 (1983).

34. Y. Mohajer, S. Bagrodia, G. L. Wilkes, R. F. Storey, and J. P. Kennedy, "New Polyisobutylene Based Model Elastomeric Ionomers, 6. The Effect of Excess Neutralizing Agents on Solid State Mechanical Properties", J. Appl. Polym. Sci., in press.

35. I. Yilgor, J. Eberle, B. C. Johnson, E. Yilgor, W. P. Steckle, Jr., D. Tyagi, G. L. Wilkes and J. E. McGrath, "Segmented Organo Siloxane Copolymers. I. Synthesis and Characterization of Siloxane Urea Copolymers, Submitted to Polymer.

36. D. Tyagi, I. Yilgor, J. E. McGrath, and G. L. Wilkes, "Segmented Organo Siloxane Copolymers. II. Thermal and Mechanical Properties of Siloxane Urea Copolymers, Submitted to Polymer.

37. T. C. Ward, T. S. Lin, "Compatibility Studies Using Solid State NMR" in Advances in Chemistry Series 206, C. D. Han ed., pp. 59-76, American Chemical Society.

38. T. C. Ward, Margaret Sheridan, and D. L. Kotzev, "Nondestructive Evaluation of Some Bonded Joints" in Mittal, K. L. (ed.), Adhesive Joints: Formation, Characteristics and Testing, Plenum Press (1984).

39. T. C. Ward, A. W. Brinkley, Margaret Sheridan, and Paul Koning, "Block Copolymers Adhesive Studies" a Chapter in Lee, L-H (ed.) Adhesive Chemistry: Developments and Trends, Plenum Press, (1984).

40. D. G. Baird, "Concepts in Rheological Studies of Polymeric Liquid Crystals", Chapter 3 in Polymeric Liquid Crystals, Plenum Press, New York (1984).

41. A. D. Gotsis and D. G. Baird, "Rheological Properties of Liquid Crystalline Melts, II. Comparison of Capillary and Rotary Rheometer Results", J. Rheol. Accepted for Publication.

42. A. D. Gotsis and D. G. Baird, "Normal Stresses in Liquid Crystalline Copolyesters", Submitted to Rheol. Acta.

(B) Preprints

1. S. Abouzahr, G. L. Wilkes, and J. E. McGrath, "Chemo-Rheological Studies of Isoprene-Butadiene Copolymers", Polymer Preprints, 22(1), 179-180 (1981).

2. T. C. Ward, D. P. Sheehy, J. E. McGrath, and J. S. Riffle, "Inverse Gas Chromatography Studies of Polydimethylsiloxane (PDMS) Polycarbonate (PC) Copolymers and Blends," Polymer Preprints, 22(1), 187-188 (1981).

3. M. K. Martin and J. E. McGrath, "Effect of Thermal History on the End-Linking of Dienyllithium Anions with Divinylbenzene," Polymer Preprints, 22(1), 212-214 (1981).

4. Y. Mohajer, G. L. Wilkes, I. C. Wang, and J. E. McGrath, "Hydrogeneated Tri-Block Copolymers of Isoprene-Butadiene-Isoprene: Effects of Variation of Architecture and Composition on Properties," Polymer Preprints, 22(2), 138-139 (1981).

5. I. Yilgor, G. L. Wilkes and J. E. McGrath, "Poly(urethane-siloxane) Copolymers. I. Reaction Kinetics of Model Systems," Polymer Preprints, 23(1), 286-88 (1982).

6. J. E. McGrath, J. S. Riffle, I. Yilgor, A. K. Banthia and G. L. Wilkes, "An Overview of the Polymerization of Cyclosiloxanes," Org. Coatings and Plastics Preprints, 46(1), (1982).

7. I. Yilgor, E. Yilgor, J. Eberle, W. Steckle, Jr., B. C. Johnson, D. Tyagi, G. L. Wilkes and J. E. McGrath, "Novel Segmented Elastomers from Amino Alkyl Terminated Dimethylsiloxane Oligomers", Polymer Preprints, 24(1), 167-170 (1983).

8. I. Yilgor, J. Eberle, A. Shaaban, E. Yilgor, W. P. Steckle, Jr., D. Tyati, G. L. Wilkes and J. E. McGrath, "Siloxane-Urea Segmented Copolymers. III. Structural Variations in the Polysiloxane Oligomers", Polymer Preprints, 24(1), 170-171 (1983).

9. D. C. Webster, P. J. Andolino, J. S. Riffle, F. L. Keohan and J. E. McGrath, "Synthesis and Characterization of Polyester-Polydimethylsiloxane Block Copolymers", Polymer Preprints, 24(1), 161-163 (1983).

10. R. D. Allen, T. L. Huang, D. K. Mohanty, S. S. Huang, H. D. Qin, and J. E. McGrath, "Ion-Containing Polymers. II. Anionic Synthesis of Ion-Containing Block Copolymers: Preparation and Hydrolysis", Polymer Preprints, 24(2), 41-44 (1983).

11. P. K. Das, R. D. Allen, T. C. Ward, and J. E. McGrath, "Chain Dimensions of Poly(Alkyl Methacrylates) by Variable Temperature Size Exclusion Chromatography", Polymer Preprints, 24(2), 103-106 (1983).

12. D. P. Sheehy, T. C. Ward and J. E. McGrath, "Applicability of the Scott Ternary Model for Interpreting the Free Energy of Mixing of Nitrocellulose Containing Blends and of Low Molecular Weight Liquids", Polymer Preprints, 24(2), 106-109 (1983).

13. A. Sha'aban, S. McCartney, N. Patel, I. Yilgor, J. S. Riffle, D. W. Dwight and J. E. McGrath, "ESCA Studies on Polydimethylsiloxane-Urea Copolymers and their Blends with Segmented Polyether-Urethanes", Polymer Preprints, 24(2), 130-134 (1983).

14. Y. Chujo and J. E. McGrath, "Synthesis of α,ω-Difunctional Fluorine-Containing Polysiloxane Oligomers Via Hydrosilation Reaction", Polymer Preprints, 24(2), 47-50 (1983).

15. I. Yilgor, E. Yilgor, B. Johnson, J. Eberle, G. L. Wilkes and J. E. McGrath, "Segmented Polysiloxane-Polyimide Copolymers", Polymer Preprints, 24(2), 78-80 (1983).

16. I. Yilgor, B. Lee, W. P. Steckle, Jr., J. S. Riffle, D. Tyagi, G. L. Wilkes and J. E. McGrath, "Segmented Polysiloxane-Polyamide Copolymers", Polymer Preprints, 24(2), 35-37 (1983).

17. I. Yilgor, K. A. Packard,, J. Eberle, E. Yilgor, R. D. Lundberg, and J. E. McGrath, "Ion-Containing Polymers. I. Alkyl Acrylate-Sulfonated Styrene Copolymers by Emulsion Copolymerization", Polymer Preprints, 24(2), 37-39 (1983).

18. I. Yilgor, G. L. Wilkes and J. E. McGrath, "Siloxane-Urea Segmented Copolymers IV. Synthesis of Cycloaliphatic Diisocyanate (H-MDI) Based Copolymers", Polymer Preprints, 24(2), 80-82 (1983).

19. I. C. Wang, R. J. Minton and J. E. McGrath "Utilization of Antioxidants During the Chemical Hydrogenation of Polydienes with p-Toluene Sulfonyl Hydrazide (TSH)", Polymer Preprints, 24(2), 28-31 (1983).

20. D. G. Baird and G. L. Wilkes, "Thermotropic Liquid Crystalline Copolyesters - Rheological Properties", ACS Preprints, 22:2, 357 (1981).

21. Eugene Joseph, G. L. Wilkes, and D. G. Baird, "Morphological Studies of Thermotropic Liquid Crystalline Polyesters Based on Polyethylene Terephthalate and Parahydroxy Benzoic Acid", ACS Preprints, 22:2, 239 (1981).

22. D. G. Baird and G. L. Wilkes, "Sandwich Injection Molding of Thermotropic Copolyesters and Filled Polyester", NATEC Papers, Society of Plastics Engrs., Bal Habor, FL, October 1982.

23. D. G. Baird and G. L. Wilkes, "Sandwich Injection Molding of Thermotropic Copolyesters and Filled Polyester", Polym. Engr. & Sci., 23:11 (1983).

24. E. Joseph, G. L. Wilkes and D. G. Baird, "Thermal Studies of Flexible and Semi-rigid Polymeric Blends", NATAS Preprints, - paper delivered in Williamsburg, VA, September 25/29, 1983.

25. R. Pisipati, E. Joseph, D. G. Gaird and G. L. Wilkes, "Thermal Studies of Flexible and Semi-rigid Polymeric Blends", NATAS Preprints, - paper delivered in Williamsburg, VA, September 24/29, 1983.

26. D. Tyagi, I. Yilgor, E. Yilgor, G. L. Wilkes and J. E. McGrath, "Thermal Analysis of Segmented Siloxane Copolymers", NATAS Preprints, paper delivered in Williamsburg, VA, September 24/29, 1983.

27. S. Bagrodia, G. L. Wilkes, and J. Kennedy, "Thermal Mechanical Analysis of Polyisobutylene Based Elastomeric Ionomers,=", NATAS Preprints, paper delivered in Williamsburg, VA, September 24/29, 1983.

28. J. P. Kennedy, R. F. Storey, Y. Mahajer, and G. L. Wilkes, "New Polyisobutylene Based Model Ionomers, Part I - Synthesis and Characterization", Abstracts IUPAC Symposium, Amherst, MA, July 1982, p. 905.

29. Y. Mohajer, G. L. Wilkes, R. F. Storey and J. P. Kennedy, "New Polyisobutylene Based Model Ionomers, Part II - Structure Property Relationships", Ibid, page 906.

30. S. Bagrodia, Y. Mohajer, G. L. Wilkes, R. F. Storey, J. P. Kennedy, "Mechanical Properties of Novel Polyisobutylene Based Elastomeric Ionomers: Effect of Molecular Architecture", Polymer Preprints 24(21), 1983).

31. E. G. Joseph, G. L. Wilkes, D. G. Baird, "Thermal and Structural Studies of Flexible and Semi-Rigid Polymeric Blends, Ibid, p. 304.

32. P. K. Das, R. D. Allen, T. C. Ward, and J. E. McGrath, "Chain Dimensions of Poly(alkyl methacrylates) by Variable Temperature Size Exclusion Chromatography", Polymer Preprints 24(2), 103 (1983).

33. D. P. Sheehy, T. C. Ward, and J. E. McGrath, "Applicability of the Scott Temary Model for Interpreting the Free Energy of Mixing of Nitrocellulose Containing Blends", Polymer Preprints 24(2), 106 (1983).

34. T. S. Lin and T. C. Ward, "Magic Angle C-13 NMR Studies of Polymer Blends Containing Poly(vinylidene fluoride)", Polymer Preprints 24(2), 136 (1983).

(C) Theses (since 1980)

1. M. K. Martin, Ph.D., Chemistry, November, 1980, "On the Nature of End-Linking Poly(dienyllithium) Chain Ends with Commercial Divinylbenzene to Form Star-Branched Polymers".
   Current Employer: 3M

2. J. S. Riffle, Ph.D., Chemistry, December, 1980, "Synthesis and Characterization of Polycarbonate-Polydimethylsiloxane Block Copolymers".
   Current Employer: Thoratec Laboratories, Inc.

3. I. C. Wang, Ph.D., Chemistry, August 1981, "Anionic Synthesis and Structure-Property Relationship for Butadiene-Isoprene Copolymers and Their Hydrogenated Derivatives".
   Current Employer: General Electric Co.

4. K. Packard, M.S., Chemistry, June, 1983, "Direct Copolymerization of Covalent and Ion-Containing Copolymers".
   Current Employer: Dow Chemical

5. A. Sha'aban, M. S., Chemistry, January, 1983, "Urea-Polysiloxane Segmented Copolymers".
   Current Employer: Dow Chemical (ASIA)

6. R. E. Jerman, M.S. Thesis, "A Rheological Characterization of Liquid Crystalline Copolymers of PET/PHB, 1981. (Rohm and Haas).

7. C. D. Nguyen, M.S. Thesis, "Mold Filling Characteristics and Molecular Orientation in Injection Molding of Liquid Crystalline Copolyesters of PHB/PET," 1982.

8. A. Gotsis, M.S. Thesis, "Comparison of Various Methods for Measuring Rheological Properties of Liquid Crystalline Copolyesters," 1983.

9. Eugene Joseph, "Morphological and Thermal Studies of a Thermotropic Liquid Crystalline Copolyesters", Ph.D. in Chemical Engineering, June, 1983.
   Current Employer: 3M

10. Anne Wood Brinkley, "Model Block Copolymer Adhesives", M.S. in Chemistry, 1982, (IBM, Tucson).

11. Daniel P. Sheehy, "Polymer Characterization by Inverse Gas Chromatography (IGC)", Ph.D. in Chemistry, 1983, Current Employer - 3M.

12. T. S. Lin, "Polymer Characterization Via Solid State NMR", Ph.D. in Chemistry, 1983.
Current Employer: University of Tapei

13. B. C. Johnson, "Polyimide-Siloxane Segmented Copolymers and Related Materials", Ph.D. Thesis, Materials Engineering Science (1984).
Current Employer: General Electric

14. D. C. Webster, "Polysiloxane Modified Engineering Thermoplastics", Ph.D. in Materials Engineering Science, 1984.
Current Employer: Sherwin Williams Company

15. C. Tran, "Polysiloxane Modified Epoxy Systems", Ph.D. in Materials Engineering Science, 1984.
Current Employer: W. R. Grace Company

16. P. K. Das, "Solution Studies of Block Copolymers by Variable Temperature SEC", Ph. D. in Chemistry, 1984.
Current Employer: Monsanto

17. R. D. Allen, "Anionic Synthesis of Homo- and Block Poly(Alkyl Methacrylate Systems)", Ph.D. in Chemistry, January, 1985.
Current Employer: IBM

18. B. Lee, "Polyamide-Polydimethylsiloxane Copolymers", M.S. in Chemistry, 1984 - currently a Ph.D. candidate.

19. A. D. Broske, "Polyamide-Polydimethylsiloxane Copolymers", M.S. in Chemistry, 1984 - currently a Ph.D. candidate.

20. N. Patel, "Surface Characterization of Siloxane Copolymers", M.S. in Materials Engineering Science, 1984.

21. A. D. Gotsis, "A Study of the Rheological Behavior of Two Thermotropic Liquid Crystalline Copolyesters", M.S. Thesis, 1984.

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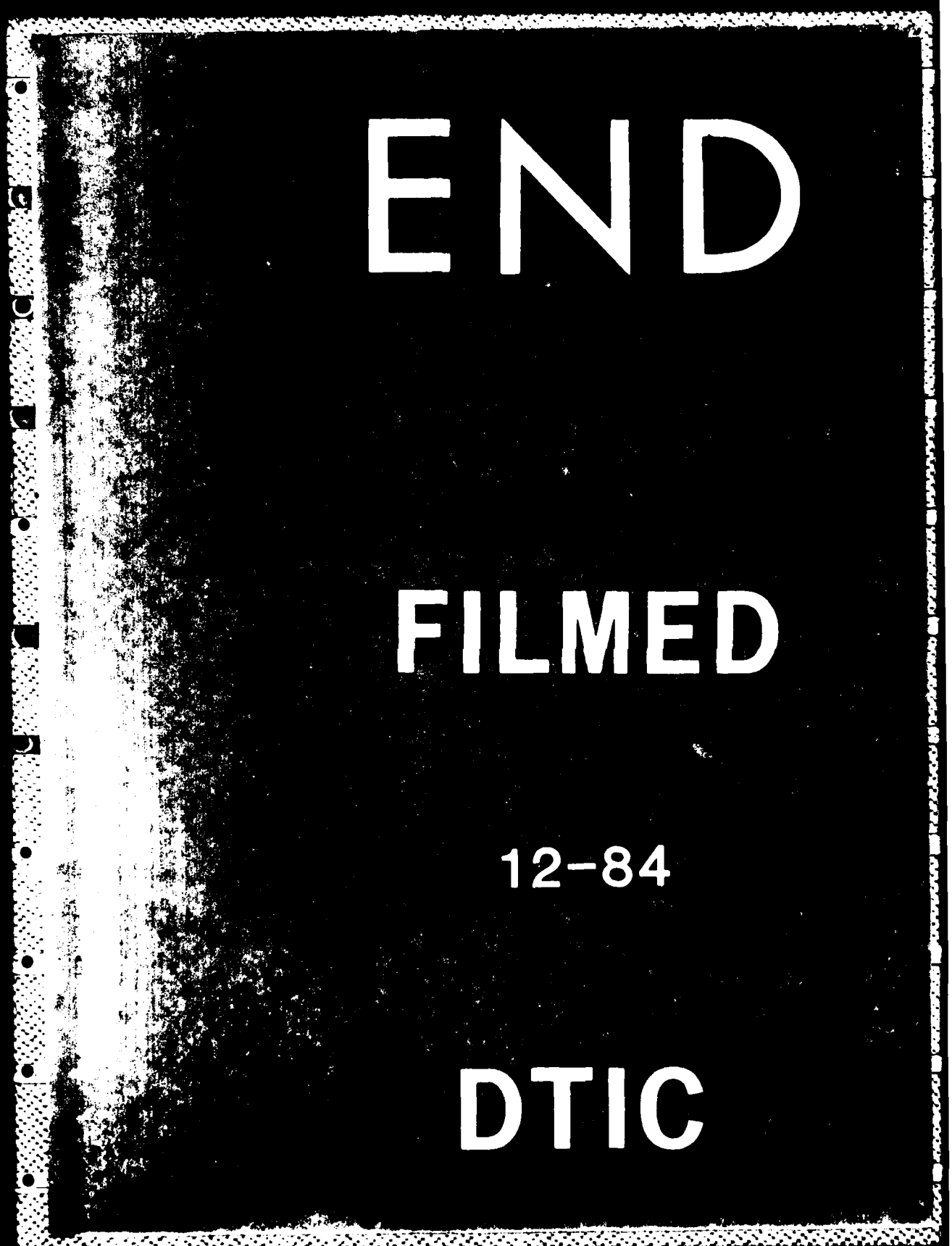
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